PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

BOWDERY, A., O.
Qinetiq Limited
IP Formalities
A4 Bldg., Cody Technology Park
Ively Road, Farnborough
Hampshire GU14 0LX
ROYAUME-UNI

Date of mailing (day/month/year)
25 October 2001 (25.10.01)

Applicant's or agent's file reference
IPD/P2765/WOD

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02837

International filing date (day/month/year)
26 July 2000 (26.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address
THE SECRETARY OF STATE FOR DEFENCE
Defence Evaluation & Research Agency
A4 Building
Ively Road
Farnborough
Hampshire GU14 0LX
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[X] the person [ ] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address
QINETIQ LIMITED
85 Buckingham Gate
London SW1 6TD
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:
The agent's address has been changed accordingly.

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
Elisabeth KÖNIG
Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 23 March 2001 (23.03.01)	
International application No. PCT/GB00/02837	**Applicant's or agent's file reference** IPD/P2765/WOD
International filing date (day/month/year) 26 July 2000 (26.07.00)	**Priority date** (day/month/year) 26 July 1999 (26.07.99)
Applicant TILSTON, John, Ronald et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

10 February 2001 (10.02.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Olivia TEFY
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 February 2001 (01.02.2001)

PCT

(10) International Publication Number
WO 01/07773 A1

(51) International Patent Classification[7]: F02K 9/74, 9/68

(21) International Application Number: PCT/GB00/02837

(22) International Filing Date: 26 July 2000 (26.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9917404.7 26 July 1999 (26.07.1999) GB

26 Jan 02

(71) Applicant *(for all designated States except US)*: **THE SECRETARY OF STATE FOR DEFENCE** [GB/GB]; Defence Evaluation & Research Agency, A4 Building, Ively Road, Farnborough, Hampshire GU14 0LX (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **TILSTON, John, Ronald** [GB/GB]; DERA Pyestock, Farnborough, Hampshire GU14 0LX (GB). **CHEUNG, Wai, San** [GB/GB]; DERA Pyestock, Farnborough, Hampshire GU14 0LX (GB).

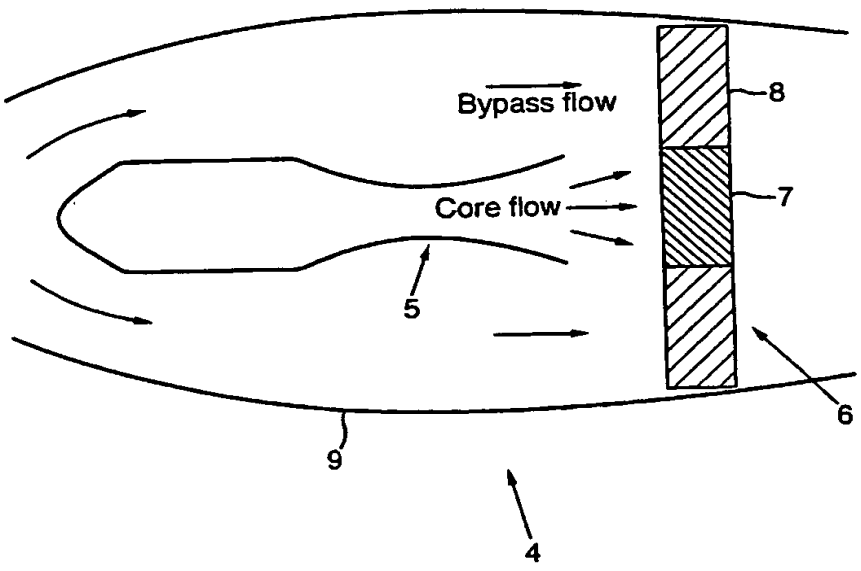
(74) Agent: **BOWDERY, A., O.**; D/IPD, DERA Formalities, A4 Bldg., Ively Road, Farnborough, Hampshire GU14 0LX (GB).

(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: HYDROGEN PEROXIDE BASED PROPULSION SYSTEM



(57) Abstract: A micro air vehicle comprising fuel tank connected to a region adapted to decompose hydrogen peroxide, and a nozzle adapted to exit the decomposition products of hydrogen peroxide to provide thrust. Preferably provide a hydrocarbon fuel is used to consume oxygen from the decomposition of hydrogen peroxide. Also an engine comprising a tank adapted to contain hydrogen peroxide, a decomposition region/chamber suitable for decomposing hydrogen peroxide, a nozzle to accelerate the resulting decomposition products, and a turbofan located downstream of the exit of said nozzle, and located within a duct so as to provide propulsive thrust.

WO 01/07773 A1

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No
PC[redacted] 00/02837

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F02K9/74 F02K9/68

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US 6 082 671 A (MICHELSON ROBERT C) 4 July 2000 (2000-07-04) figures 1,4	1,7
P,X	US 5 932 940 A (ANANTHASURESH G K ET AL) 3 August 1999 (1999-08-03) the whole document	4,5,7,8
X	& EP 0 920 575 A 9 June 1999 (1999-06-09)	1,7
A	US 5 477 672 A (TSUJIKADO NOBUO ET AL) 26 December 1995 (1995-12-26) figures	1,4,7,10
A	US 4 135 361 A (EISENHAURE DAVID B) 23 January 1979 (1979-01-23) figures	1,4,7,10

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 October 2000	19/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Argentini, A

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No
PCT/[redacted]00/02837

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 898 794 A (ARIGA HAJIME) 12 August 1975 (1975-08-12) figures	1,4,7,10

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

[redacted] Application No
P[redacted]B 00/02837

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6082671 A	04-07-2000	NONE	
US 5932940 A	03-08-1999	AU 4040197 A	09-02-1998
		EP 0920575 A	09-06-1999
		NO 990199 A	12-02-1999
		WO 9802643 A	22-01-1998
US 5477672 A	26-12-1995	JP 2759748 B	28-05-1998
		JP 7145742 A	06-06-1995
US 4135361 A	23-01-1979	NONE	
US 3898794 A	12-08-1975	JP 48099509 A	17-12-1973
		JP 49001926 A	09-01-1974
		DE 2315787 A	04-10-1973
		FR 2179019 A	16-11-1973
		GB 1417614 A	10-12-1975

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
IPD/P2765/WOD		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02837	26/07/2000	26/07/1999
Applicant		
THE SECRETARY OF STATE FOR DEFENCE...		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

To:
D/IPD
DERA Formalities
Attn. BOWDERY, A.O.
A4 Bldg, Ively Road
Farnborough
Hants GU14 0LX
UNITED KINGDOM

Date of mailing *(day/month/year)*	19/10/2000
Applicant's or agent's file reference: IPD/P2765/WOD	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No.: PCT/GB 00/02837	International filing date *(day/month/year)* 26/07/2000
Applicant: THE SECRETARY OF STATE FOR DEFENCE...	

1. [X] The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

[ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

[ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Christine Schipflinger

Form PCT/ISA/220 (July 1998)

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international pbulication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When? Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

NOTES TO FORM PCT/ISA/220 (continue)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped),whether

(i) the claim is unchanged;

(ii) the claim is cancelled;

(iii) the claim is new;

(iv) the claim replaces one or more claims as filed;

(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international appplication is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
IPD/P2765/WOD		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02837	26/07/2000	26/07/1999
Applicant		
THE SECRETARY OF STATE FOR DEFENCE...		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

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PATENT COOPERATION TREATY

REC'D 14 NOV 2001
WIPO PCT

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
IPD/P2765/WOD		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02837	26/07/2000	26/07/1999
International Patent Classification (IPC) or national classification and IPC F02K9/74		
Applicant QINETIQ LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
10/02/2001	12.11.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Teusch, R Telephone No. +49 89 2399 7827

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02837

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

4	as originally filed			
1-3	as received on	18/09/2001	with letter of	18/09/2001

Claims, No.:

1-9	as received on	18/09/2001	with letter of	18/09/2001

Drawings, sheets:

1/1	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)
   see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 1, 6
	No:	Claims 2-5, 7-9
Inventive step (IS)	Yes:	Claims
	No:	Claims 1-9
Industrial applicability (IA)	Yes:	Claims 1-9
	No:	Claims

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item I

Basis of the report

The amendment "...the hydrogen peroxide is pressurized thus providing pressurized oxygen" in the last paragraph of page 1 filed with the letter dated 18.09.2001 could not be found in the original disclosure and consequently introduces subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT.

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

   D1: WO 98/02643
   D2: US-A-5 477 672
   D3: US-A-3 898 794

2. Document D1 (see Figs. 11 A-F, especially 11E) relates to:
   A micro air vehicle (a micro rocket is considered to be a specific example for a micro air vehicle, it meets the definition given on page 1 lines 6-7 of the present application, being an air vehicle having a weight less than 2 kg) comprising a fuel tank (page 83 lines 12-15) connected to a region adapted to decompose hydrogen peroxide, a nozzle (909, page 34 lines 25-26) adapted to exit the decomposition products of hydrogen peroxide to provide thrust and means to provide a hydrocarbon fuel adapted to burn by consuming oxygen (bipropellants including a hydrocarbon can be used, page 34 lines 10-17).
   Document D1, which is considered to represent the most relevant state of the art, discloses a micro air vehicle from which the subject-matter of claim 1 differs in that the vehicle further comprises pressurized oxygen to pressurize said fuel. However it is generally known in the prior art to use pressurized oxygen to pressurize hydrocarbon in bipropellant rockets. Consequently, the subject-matter of independent claim 1 cannot be considered as involving an inventive step (Article 33(3) PCT).

3. Document D1 also discloses a method of propelling a micro air vehicle (micro

rocket) comprising decomposing hydrogen peroxide (a monopropellant or bipropellants can be used, page 34 lines 10-17) and exiting the decomposition products through a nozzle to provide thrust (909, page 34 lines 25-26).
A method of propelling a micro air vehicle with all the features defined in independent claim 4 is thus already known independently from document D1. Consequently, the subject-matter of claim 4 is not new (Article 33(2) PCT).

4. Furthermore, as in the present application it is not disclosed how to adapt the propulsion system to a micro air vehicle, a propulsion system similar to that disclosed in the application is also known from documents D2 (see Fig. 4 disclosing H_2O_2 fuel tank 7, H_2O_2 decomposition zone 12 and nozzle 3, means for providing hydrocarbon fuel adapted to burn by consuming oxygen from the decomposition of H_2O_2 column 4 lines 43-51) and D3 (see Fig. 1 disclosing H_2O_2 fuel tank 10, H_2O_2 decomposition zone 20 and nozzle 48, means for providing hydrocarbon fuel adapted to burn by consuming oxygen from the decomposition of H_2O_2 column 3 lines 31-39).

5. Document D2 (see Fig. 4) relates to:
An turbo-ram jet (rocket) comprising an engine having connection means 15 to a tank 7 adapted to contain hydrogen peroxide, a fuel tank 7 connected to a region adapted to decompose hydrogen peroxide, a decomposition region/chamber 12 suitable for decomposing hydrogen peroxide, a nozzle 3 to accelerate the resulting decomposition products, a turbofan 4 located downstream of the exit of said nozzle, and located within a duct (as rotor 4 is part of turbine 2 it has a housing) so as to provide propulsive thrust and means to provide a hydrocarbon fuel adapted to burn by consuming oxygen from the decomposition of hydrogen peroxide (column 4 lines 43-51).
A similar engine is disclosed in document D3 (Fig. 1 with turbine wheel 52).
As it is not disclosed how to adapt the propulsion system to a micro air vehicle, a air vehicle with all the features defined in independent claim 2 is thus already known independently from documents D2 and D3. Consequently, the air vehicle disclosed in independent claim 2 and the method of propulsion of an air vehicle disclosed in independent claim 7 (which does not mention a micro air vehicle) are not new (Article 33(2) PCT).

6. Dependent claims 3, 5-6 and 8-9 do not appear to contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty or inventive step, because they are either known from the documents of the search report or lie within the scope of the customary practice followed by persons skilled in the art. In particular documents D2 (column 4 lines 43-51) and D3 (Fig. 1, column 3 lines 31-39) disclose means for providing hydrocarbon fuel adapted to burn by consuming oxygen from the decomposition of H_2O_2.

Re Item VII

Certain defects in the international application

1. Independent claims 1, 2, 4 and 7 are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (document D1 for claims 1 and 7, document D2 for claims 4 and 10) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

3. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1-D3 is not mentioned in the description, nor are these documents identified therein.

4. Following comments should be noted:
   - 4.1 The power plant 1, fuel tank 2 and combustion chamber/nozzle 3 referred to on page 2, second last paragraph, could not be found in Fig. 1.
   - 4.2 The wording of the last paragraph on page 4 is unclear.
   - 4.3 In claim 7 it appears that "within a duct" is meant rather than "with a duct".

Re Item VIII

Certain observations on the international application

1. The present application does not meet the requirements of Articles 5 and 6 PCT because both the description and the claims do not disclose the invention in a

manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art (see also PCT Guidelines II-4.1(i), (ii)).

2. While the general features and functions of a propulsion system for micro air vehicles are similar to those of conventional normal scale vehicles, the specific design, operation and manufacturing details for such micro-systems are quite different from those of macro-systems due to the inherent changes in physical processes at small sizes and due to the material requirements for producing and using such micro-components.
Some of the problems arising when moving from the macro-scale to the micro-scale are mentioned in the disclosure ("design and selection of material for the combustion chamber/nozzle are very challenging", "very few materials will be suitable", "very efficient cooling techniques must be implemented", "increase in combustion temperature and complexity in the fuel system", "the front of the combustion chamber has to be shaped to avoid flow separation", page 3) but no solution is provided therefore.

3. Relating to claims 2, 3 and 7-9, the positioning and the connection between the nozzle and the shrouded fan is very obscure. Furthermore, the working principle of fan, turbine and rocket and the interaction between them is not disclosed in the description and also not deducible from Fig. 1.

4. Additional to the general objections under points 1., 2., and 3. regarding the disclosure and clarity of the subject-matter of the application further unclarity remains on following items:
   * it is not disclosed how the H_2O_2 is decomposed (catalytically?)
   * the fuel system is not described, it is not disclosed how the hydrocarbon is burned (ignition?), by which means it is provided, how it is pressurized
   * it is not disclosed how the region adapted to decompose hydrocarbon looks like
   * it is not clear what should be understood under turbofan, not clear if the fan is positioned downstream and radially outside the nozzle and the turbine radially inside the nozzle, how turbine and fan are connected and how they work, if the fan duct surrounds the rocket engine and how this is fixed
   * it is not disclosed how the miniature blades of the turbine and fan can be

manufactured, how the bearings subjected to the high rotational speed of the fan look like

* on what base the inventors have determined that the engines can be built small enough (page 1 third paragraph)
* what material, fuel system and cooling techniques to use

5. Although claims 1, 2, 4 and 7 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.
Hence, claims 1, 2, 4 and 7 do not meet the requirements of Article 6 PCT.
In order to overcome this objection, it would appear appropriate to file an amended set of claims defining the relevant subject-matter in terms of a single independent claim in each category followed by dependent claims covering features which are merely optional (Rule 6.4 PCT).

6. Claim 1 appears to relate rather to a propulsion system for a micro air vehicle comprising the mentioned features than to a micro air vehicle.

7. Further unclarity arises (Article 6 PCT), because the independent apparatus claims relate to bipropellants, while the independent method claims disclose a monopropellant.

Claims

1. A micro air vehicle comprising fuel tank connected to a region adapted to decompose hydrogen peroxide, and a nozzle adapted to exit the decomposition products of hydrogen peroxide to provide thrust.
2. A micro air vehicle as claimed in claim 1 including means to provide a hydrocarbon fuel adapted to burn by consuming oxygen from the decomposition of hydrogen peroxide.
3. A micro air vehicle as claimed in claims 2 including pressurised oxygen to pressurise said fuel.
4. An engine comprising connection means to a tank adapted to contain hydrogen peroxide, a decomposition region/chamber suitable for decomposing hydrogen peroxide, a nozzle to accelerate the resulting decomposition products, and a turbofan located downstream of the exit of said nozzle, and located within a duct so as to provide propulsive thrust.
5. An engine as claimed in claim 4 additionally comprising a means for providing hydrocarbon fuel to said decomposition region/chamber or nozzle to be oxidised at least in part by the oxygen produced by the decomposition.
6. A micro air vehicle comprising an engine as claimed in claims 4 or 5.
7. A method of propelling a micro air vehicle comprising decomposing hydrogen peroxide and exiting the decomposition products through a nozzle to provide thrust.
8. A method as claimed in claim 7 including burning a hydrocarbon fuel with the oxygen produced from said combustion.
9. A method as claimed in claim 8 wherein said hydrocarbon is pressurised.
10. A method of propulsion comprising decomposing hydrogen peroxide and exiting the resulting said decomposition products through a nozzle towards a turbofan located with a duct.
11. A method as claimed in claim 10 wherein additionally comprising burning a hydrocarbon fuel with oxygen provided from decomposition.
12. A method of propelling a micro air vehicle as claimed in claims 10 or 11.

Hydrogen Peroxide Based Propulsion System

The invention relates to hydrogen peroxide (H_2O_2) engines and in particular to a novel hybrid rocket/turbine hydrogen peroxide based engine and hydrogen peroxide based propulsion system for micro air vehicle propulsion.

Micro air vehicles (MAVs) play a key role in military and surveillance operations. For these MAVs, a range of engine characteristics is needed to meet specific requirements, such as low speed, low noise, high speed, etc. In this specification MAV's are defined as air vehicles which have a wingspan of 1 metre or less and/or a weight 2kg or less. Features such as weight, ease of starting, reliability, etc. are important in the choice of the power plant. Air breathing engines or motors are usually attractive on weight grounds because they do not have to carry their own oxidant. However this may not be so important at small scales when the mass of the engine itself is relatively high. In addition, of course, small engines have relatively poor thermal and propulsive efficiency due to low cycle temperatures.

Hydrogen peroxide engines are known. The inventors have determined that these engines can be built small enough and give adequate performance requirements for use in MAV's. Hydrogen Peroxide can nowadays be generated 'in the field' by electrolytic techniques. It can be decomposed catalytically to produce steam and oxygen at high temperature and is an acceptable propellant in its own right with a high specific thrust and a low infrared (IR) signature.

The invention comprises a micro air vehicle comprising a tank adapted to contain hydrogen peroxide and connected to a region adapted to decompose hydrogen peroxide, and a nozzle adapted to exit the decomposition products of hydrogen peroxide to provide thrust.

Preferably a hydrocarbon fuel is provided to consume oxygen from the decomposition of hydrogen peroxide. Preferably pressurised oxygen is used to pressurise said fuel.

Further is provided a method of propelling a micro air vehicle comprising decomposing hydrogen peroxide and exiting the decomposition products through a nozzle to provide thrust

The invention also comprises an engine comprising a tank adapted to contain hydrogen peroxide, a decomposition region/chamber suitable for decomposing hydrogen peroxide, a nozzle to accelerate the resulting decomposition products, and a turbofan located downstream of the exit of said nozzle and located within a duct so as to provide propulsive thrust.

Preferably a hydrocarbon fuel is provided to consume oxygen from the decomposition of hydrogen peroxide. Preferably pressurised oxygen is used to pressurise said fuel.

The invention will now be described with by way of example only and with reference to the following figures of which:

Figure 1 shows an embodiment of the invention comprising a fuel tank integral with a nozzle combustion chamber.

Figure 2 shows an embodiment of the invention comprising combustion chamber/nozzle and a ducted fan.

In a simple embodiment of the invention shown in figure 1, a MAV power plant 1 includes a fuel tank 2 containing 34g of H_2O_2. To hold this weight of fuel, the fuel tank can be a simple cylinder (2cm in diameter and 7.5cm in length). The fuel tank alone will weigh about 16g if it is made of aluminium and its thickness (1mm) should be sufficient to contain the pressure inside the tank. The fuel tank is connected to a combustion chamber/nozzle 3 of weight less than 2g.

The decomposition of H_2O_2 is an exothermic process in which a substantial rise in temperature occurs. Thermodynamic calculations on a 90% H_2O_2 solution show that a

temperature of 1022K (749°C) and a pressure of 35.5bar (515psi) are achievable when the decomposition products are allowed to expand adiabatically to atmospheric pressure.

A simple convergent/divergent nozzle is used in the flow parameter calculations necessary to diminish the combustion chamber pressure and nozzle exit area. A chamber pressure of 2.07bar (30psi) and a nozzle exit diameter of about 2mm will produce a mass flow through the nozzle of about 0.17g/s and an nozzle exit velocity of M 1.1. The thrust produced now is about 0.124N which is comparable to the amount required to propel an MAV. A monopropellant (H_2O_2) propulsion system has the advantages of low exhaust temperature and simple equipment design.

In a preferred embodiment, a bipropellant system uses hydrocarbon fuel to consume the excess oxygen. This system uses an additional tank to store the hydrocarbon. This has a clear advantage in endurance over the monopropellant system. However, the gain in endurance must weigh against the increase in combustion temperature and complexity in the fuel system. At temperatures in excess of 2400K, very few materials will be suitable for making the combustion chamber. Also, very efficient cooling techniques must be implemented to avoid damage to the combustion chamber. Preferably the propulsion system utilises hydrogen peroxide and kerosene as fuel and oxygen as the oxidant. A bipropellant (H_2O_2 and kerosene) propulsion system has a 70% improvement on flight endurance but has high exhaust temperature (circa 2700K) which makes the design and selection of material for the combustion chamber/nozzle very challenging. A bipropellant system with on-board oxygen gives the best flight endurance.

In the most preferred embodiment the system comprises a bipropellant system as described above with the addition of a ducted fan. Such an arrangement is not known per se. Figure 2 shows a figure showing the arrangement 4 of a hydrogen peroxide based ducted fan engine comprising a decomposition chamber/nozzle arrangement 5, and a turbofan 6 comprising turbine 7 and fan 8 arranged within a duct 9. In the ducted fan engine design, air passes through the outside of the combustion chamber/nozzle. The front of the combustion chamber has to be shaped to avoid flow separation. The combustion chamber/nozzle will attain very high temperatures during operation and the bypass flow will help to cool the